

Visual Acuity Testing in Pre-School Aged Children - What Can Be Expected?

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Abstract

Three hundred and sixty pre-school aged children underwent orthoptic screening as part of The Outreach Programme run by The Orthoptic Department of Sydney Eye Hospital. The children were screened at Kindergartens and Child Care Centres in the inner city. Of the 360 children screened 353 (98%) cooperated with monocular Sheridan Gardiner (SG) visual acuity testing at 6 metres. Of the children participating in visual acuity testing 79.9% managed SG linear testing, with 20.1% of the children being tested with SG singles. There was a significant difference in the age of children who completed the SG singles versus SG linear method of testing. SG singles testing was required more often with the younger children. The average visual acuity score for SG singles assessment was 6/6 part, with the majority of children achieving 6/6; whereas for SG linear assessment the average score was 6/9 plus, with the majority of children achieving 6/9. It was found that irrespective of the visual acuity test method used, older children achieved slightly better visual acuity results than younger children. It was also found that irrespective of the child's age SG singles testing produced better visual acuity results than SG linear. Reduced visual acuity was noted in 9.8% of children with SG singles testing, and 2.5% with SG linear.

Key Words:

Pre school vision screening, visual acuity, Sheridan Gardiner singles, Sheridan Gardiner linear.

Introduction

Numerous reviews of screening studies carried out during the various stages of visual development in childhood are contained in the literature.^{1,2,3,4,5} Some authors feel that screening is of minimal value to visual outcomes, whilst others indicate that vision screening is particularly effective when carried out at a young age.⁶ Ingram⁷ reports that screening at preschool age is supported on the grounds that squint and amblyopia would be identified at an age when remedial treatment might be successful. Amblyopia is described by Taylor⁸ as "a preventable visual disability affecting 1-3% of the general population and up to 5% of the preschool age group." It is the "commonest disorder encountered in paediatric ophthalmology clinics"⁸. Edwards⁶ reported that Ehrlich et al found strabismus & amblyopia to be the two main defects preventing normal visual development, being present in 5-8% of children at school entry. Elston⁹ states that "amblyopia in preschool children is asymptomatic and, if it is not due to, or accompanied by strabismus, will only be detected fortuitously unless screened for."

Beardsell³ supports these findings stating "it has proved possible to test children quickly and accurately" at a preschool age. The Orthoptic Association of Australia NSW Branch's document titled *The Orthoptist's Role in Vision Screening: Review & Recommendations*¹⁰ states that the aim of vision screening is to identify ocular problems that may cause permanent visual loss or interfere with classroom learning. The document also

recommends that vision screening be carried out during a critical period of visual and ocular development.

The Orthoptic Department of Sydney Eye Hospital established an Outreach Vision Screening Programme in April 1995. The programme provides an orthoptic vision screening service to three and four year old children attending eighteen Child Care Centres and Pre-schools in the vicinity of the hospital.

The Outreach Vision Screening Programme is conducted once a week by the Orthoptic Student Supervisor and is also attended by orthoptic students on clinical placement from the University of Sydney. The testing procedure involves assessment of visual acuity, cover testing, convergence and stereoacuity assessment with the Langs I and/or II stereoacuity tests.

The Programme has proved to be worthwhile, as approximately 8% of the children screened have been found to have a visual defect requiring follow-up ophthalmological investigation. Of the children detected with ocular abnormality, the majority had reduced visual acuity in the absence of strabismus. The study to be presented will only examine information relating to visual acuity testing.

Method

Appleboom¹¹ reported that, since the earliest screening programme which was initiated in 1899, many alterations to original screening procedures have occurred after consideration of test reliability, testing conditions and child maturity. Currently "a variety of screening tests are in use because it is unclear which is the best for the detection of visual deficit" in preschool aged children.¹² The literature describes many forms of visual acuity testing procedures,^{1,2,13-22} however it was Fern¹⁹ who concluded that "a well designed preschool visual acuity test should consist of high contrast Snellen optotypes without directional components that progress in 0.1 log steps down to a level of 6/3". Fern also reports that "of the tests that have been standardised Sheridan Gardiner comes closest to meeting these criteria".

Preschools within the vicinity of the hospital were approached. Those interested in participating in the Programme were provided with an explanation of the testing procedures and consent forms which were to be signed by a parent/guardian and collected from each child prior to screening. The consent form contained details of the child's name, gender and date of birth.

The testing procedure used for the Outreach

Vision Screening Programme, visual acuity (VA) was assessed monocularly (right eye prior to left) at 6m using a back lit linear Sheridan Gardiner (SG) chart. All children were encouraged to attempt SG linear testing. If the children were unable to perform the SG linear test, they were then assessed using SG single letters. Prior to commencing the test each subject was shown the SG key card and a trial of matching the letters was carried out to ensure that the principle of the test was understood.

Visual acuity results for each eye and the test method used were documented for each subject. VA was assessed down to 6/5 using SG linear and 6/3 using SG singles where applicable. For research purposes the visual acuity was recorded as 'part', when there was plus 2 or minus 2 letters recognised on a line. That is, if the VA was 6/6-2 it was recorded as 6/6 part, and if the VA was 6/6+2, it was recorded as 6/5pt. When there was plus 1 or minus 1 on a line, the VA was recorded simply as that line. For example 6/6+1 would be rounded to 6/6. If the child was unable to perform either of the VA tests monocularly at 6m, no result was recorded.

Results & Discussion

Three hundred and sixty pre-school children from 18 individual inner city child care centres underwent orthoptic screening over a period of approximately 8 months. Roughly equal numbers of males and females were tested. In this study 7 of the 360 (2%) children screened were unable to have their VA assessed. Five of these children would not allow the orthoptist or orthoptic students to occlude either eye. The remaining two children were unable to manage VA testing due to intellectual impairment. Fitzgerald's paper⁵ titled the "Incidence of reduced visual acuity and squint in preschool children aged three in Australia" reported that "6.5% of children could not do the SG singles VA test at 6m". The small percentage of children in our study (2%) who were unable to participate in visual acuity assessment may be attributed to the older age of the majority of the children.

The majority of the children tested 282/353 (79.8%) managed to carry out the SG linear test, the remaining 71 (20.1%) of participants having to re-attempt VA assessment with SG singles. The children who required re-assessment with the SG singles tended to lose interest in the SG linear 'matching game' or found the method difficult and refused to continue. Several children claimed that they could not see the letters on the SG linear chart.

The data studied were found to be suitable for parametric statistical analysis. A t-test was carried out to compare the ages of the children performing SG singles versus SG linear. There was a significant age difference found ($t = -7.57$, $df = 351$, $p < 0.001$) with younger children requiring the use of SG singles more often than the older children. The average age of children tested with SG singles being 43.5 months (approx 3 1/2 years), and 50.3 months (approximately 4 years) with SG linear.

Visual acuity scores were coded for statistical analysis as:

- 1= 6/60
- 2=6/36
- 3= 6/24
- 4= 6/18
- 5= 6/12 part
- 6= 6/12
- 7= 6/9 part
- 8= 6/9
- 9= 6/6 part
- 10= 6/6
- 11= 6/5 part
- 12= 6/5

There was no significant difference in the visual acuity results for the right and left eyes for either the SG singles ($t = -0.48$, $df = 96$, $p = 0.632$) or SG linear test methods ($t = 0.21$, $df = 281$, $p = 0.83$). Analysis showed no order, learning or fatiguing effect with either VA assessment method. This finding was also reported by Fitzgerald in the Orthoptic Association of Australia Study⁵. The VA results for each of the right and left eyes were therefore studied together as a group. Subjects scoring different VA results between the two eyes, had their result codes averaged. As a result of this, intermediate codes were created where scores fell between two visual acuity categories.

The average visual acuity score for children assessed with SG singles was 6/6 part, with the most common visual acuity score being 6/6 (29.5%).(Figure 1.)(Mean 8.84, Std Dev 1.82, Mode 10)

The average visual acuity score for children assessed with SG linear was 6/9 'plus', with the most common visual acuity score being 6/9 (27%).(Figure 2.)(Mean 8.64, Std Dev 1.53, Mode 8)

In order to investigate the effect of age differences and the effect of differences in the test method employed on the VA score achieved by preschoolers the group was sub-divided. Group 1 was comprised of preschoolers who were 40 months or younger and Group 2 of children older than 40 months. The result of splitting the group into two age categories meant that there were disproportionate numbers in each group, with the majority of children falling into Group 2. In order for statistical testing to be valid, a random sample of subjects from Group 2

was compiled to equalise the numbers in the two age sub-groups.

Analysis of Variance (ANOVA) of the sub-groups showed that :

1. SG Singles method of testing produced higher (better) VA scores ($x = 8.84$) than the SG Linear method of testing. ($x = 8.24$) ($F = 1, 131, 4.74$, $p = 0.031$).
2. Preschoolers 40 months and younger achieved lower VA scores ($x = 8.21$) than preschoolers older than 40 months ($x = 8.77$) ($F = 1, 131, 3.99$, $p = 0.34$).

The two-way interactions ANOVA showed no interaction, that is, SG Single VA scores are higher than SG Linear VA scores for both age groups; and preschoolers 40 months and younger achieve lower VA scores than preschoolers older than 40 months for both of the VA testing methods. ($F = 1, 131, 0.93$, $p = 0.34$) In other words: SG single letters produced VA scores better than SG linear testing irrespective of the subject's age; and subjects older than 40 months achieved a significantly better VA score than subjects 40 months or younger irrespective of the VA test method used.

These results confirm two aspects of visual acuity assessment that have previously been suspected but unconfirmed statistically, namely:

1. Preschoolers find the SG Singles a much easier VA test than SG Linear and achieve better results with SG Singles. This finding is similar to that reported by Shaw²³ who stated that "single letter optotypes are generally considered to overestimate visual acuity," and
2. Mature preschoolers generally achieve better VA results than immature preschoolers on any VA test. This finding is in line with Elston's editorial⁹ which stated that "the visual acuity of children increases with age."

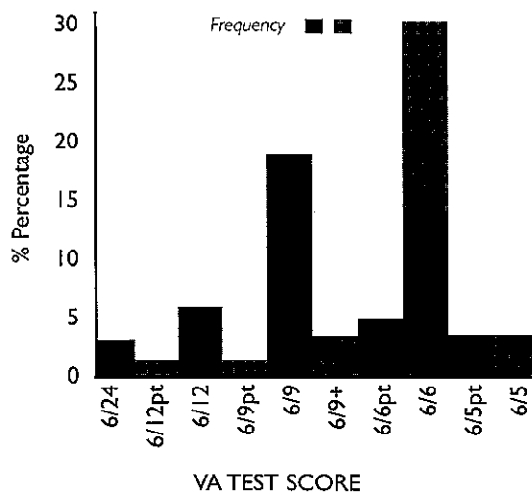
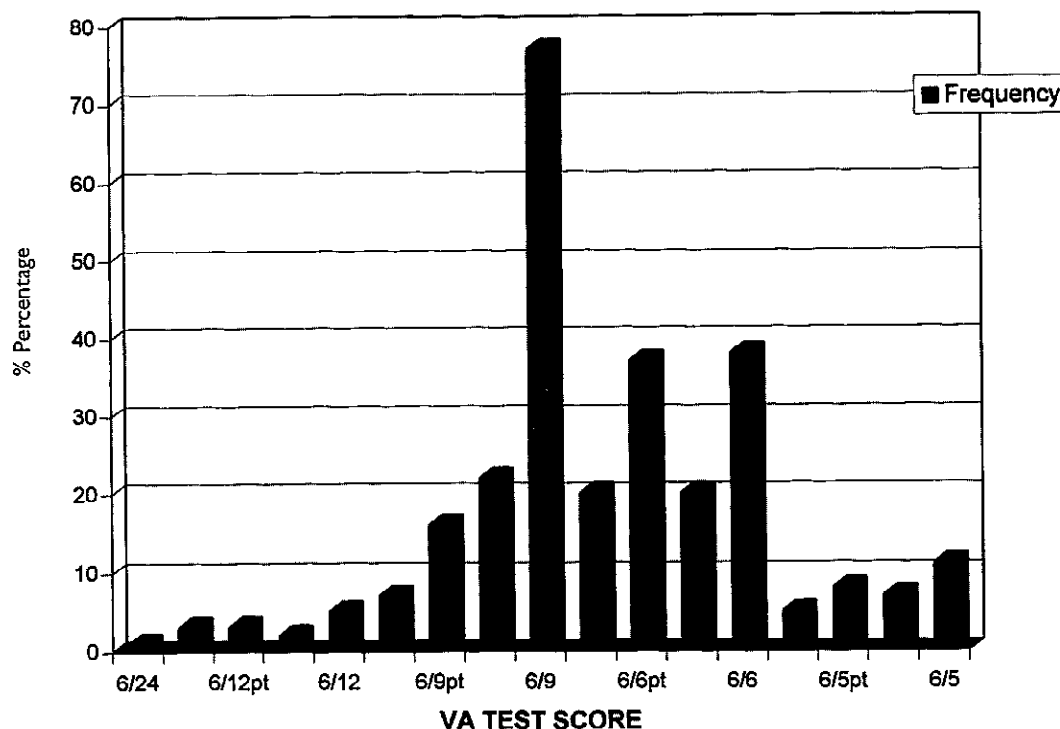


Figure 1
SG Singles Test Scores

Figure 2

SG Linear Test Scores
Intermediate codes
eg. 6/9+
(between 6/9 and 6/6pt)
are not labelled.



The referral criterion used by the Outreach Vision Screening programme was:

Preschoolers scoring less than 6/9 with SG Singles were referred on for further ophthalmic investigation. Preschoolers scoring less than 6/12 with SG Linear were also referred on for further ophthalmic investigation.

Defective visual acuity (using the referral criterion) was detected in 9.8% of preschoolers assessed with SG Singles and 2.5% of preschoolers assessed with SG Linear. This notable difference between SG Singles and Linear may be due to the research design, whereby children claiming that they could not 'see' the SG Linear test were then re-tested with the SG Singles. This re-testing procedure was carried out for the purpose of this project and ensured that the SG linear test was not being abandoned by the preschooler merely due to the test's complexity.

The percentage of children referred for follow up investigation from the Outreach Vision Screening Programme appears to be in line with other studies. Williamson et al¹² investigated an inner city preschool population & reported that "10% of the children who were screened were referred" to a hospital service, and 58.2% of these children were found to have refractive aetiology.

Ingram et al⁷ found that approximately 8% of the preschool population screened by them, required follow-up assessments. Verin²⁴ suggests that "15% of children under the age of 6 years" were found to have a visual anomaly. Fitzgerald⁵ reported an incidence of 14.7% of reduced VA detected during screening of three year old

preschoolers in Australia.

The high incidence of reduced vision due to refractive error, independent of strabismus detected by screening programmes, is well cited in the literature.^{5,7,12} Of the 30 children referred from the Outreach Vision Screening programme 17 attended the Orthoptic Department at Sydney Eye Hospital for follow up assessment. Of these nine (52.9%) were diagnosed with a significant refractive error in the absence of strabismus, two (11.7%) had strabismus, one of which also had a refractive error, three (17.6%) had other ocular pathology and three (17.6%) children had no apparent visual defect on subsequent testing.

Fern¹⁹ reports that, "the need for visual acuity assessment in pre-school age children has been long recognised, yet there are no standardised visual acuity norms or screening criteria." The findings of this study provide valuable normative data for visual acuity assessment in pre-school aged children.

Conclusion

The results of the Outreach Vision Screening Programme confirm statistically that preschoolers find the SG Singles a much easier test to perform than SG Linear, with better visual acuity results being obtained with SG Singles. Also the age factor is relevant when considering the normal level of visual acuity in preschoolers. The level of visual acuity obtained improves with age.

The Orthoptic Department of the Sydney Eye Hospital will continue to carry on the Outreach Vision Screen Programme which has proven to be a valuable service, well supported by parents and the Child Care Centres.

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